



SEMANTIC-DRIVEN
KNOWLEDGE-ENABLED COGNITIVE
DECISION SUPPORT SYSTEM

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A thesis submitted for the degree of Doctor
of Philosophy

July 8, 2014

CERTIFICATE OF AUTHOR- SHIP/ORIGINALITY

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature of Candidate

To my parents...

Acknowledgements

All praises are due to Allah Almighty, The Most Beneficent, The Most Merciful, Who has enabled me to achieve my dreams. All the goals that I have achieved are due to His mercy; while all the mistakes are mine.

On completion of this long but immensely rewarding endeavor, I would like to thank all the individuals and organisations, who have facilitated, encouraged and sometimes pushed me to be where I am today.

First of all, I would like to offer my deepest gratitude and respect to my principal supervisor Professor Jie Lu, who has been a constant inspiration, support and guidance throughout; always available despite her extremely busy schedule. Despite my naivete, she has always guided me in the most insightful manner on professional, as well as personal level. Her pleasant demeanour and ever smiling face has always been a source of solace for me. It has been my privilege and honour to work under her exceptional supervision.

I would also like to thank my co-supervisor Dr. Farookh Khadeer Hussain for his continuous encouragement and support. Throughout my research he has made himself available for frequent and detailed discussions about my research, which have enabled me to keep on track in terms of focus and time. He has also been a huge support in my work-related issues.

My special thanks are extended to the world class researchers, Professor Hai Zhuge and Professor Witold Pedrycz, for their one on one meetings to discuss my research and give their precious feedback on it. It was absolute honour and privilege to be able to meet them in person and to get to show them my work.

A special thanks goes to Dr. Fengjie Wu, for sparing a huge amount of time to hold discussions with me about my research and providing insightful and valuable suggestions, which improved the quality of this study to a great extent. I would also like to thank all the anonymous reviewers across the world, for their fantastic comments on each of my manuscripts submitted for publication during this study.

I am indebted to my colleagues at the *Decision Systems and e-Service Intelligence Lab*, for their valuable feedback, critical comments and suggestions during all my presentations as well in as one on one meetings.

Finally, my deepest gratitude goes to my family who have believed in me in times when I myself couldn't. I owe all my achievements in life to my parents, Zaib-un-Nisa Memon and Muhammad Ishaque Memon, who taught me to dream; and instilled in me the passion and conviction to achieve them. My greatest thanks is due to my brother Abdul Rauf Memon, for putting my life above his own so that I could come to Australia to achieve my dream. I am also indebted to my other siblings for their unconditional love; Maria for always making me laugh in stressful times; Abdul Basit for listening to me and giving me the most wise advice ever; Naseem for her unwavering faith in me; Ayaz for his unconditional support; and Shameem for introducing me to the world of books, and for being my first mentor.

Abstract

The importance of knowledge and cognition in business intelligence and decision support systems (DSS) is indisputable. However two major issues, a) *biases* in cognition, and b) *knowledge integration overhead* in knowledge warehousing, hinder their optimum utility in such systems. We address the issue of *biases* by proposing *semantic de-biased associations (SDA) model*, which is an improvement over the conventional causal map representation of mental models. SDA model incorporates *semantics* and *contextual information* to implement automated de-biasing by employing de-biasing techniques and algorithm into the inherent process of mental model elicitation, storage and retrieval. An elicitation process customised for SDA-based representation was also proposed namely *SDA articulation and elicitation cycle*. SDA model automates the process of mental model validation and integration, so as to prevent any espoused theories to be stored in the system. It also provides faster access to relevant knowledge, while creating a *knowledge cycle* between user and the system, which provides learning and knowledge growth opportunities to the system users, promoting organizational learning.

The issue of *knowledge integration overhead* is dealt with by proposing a unified, standard storage structure for knowledge warehousing in *subject-oriented semantic knowledge warehouse (SSKW)*. The unified storage structure is achieved through categorising knowledge on syntactic level, and creating universal templates of these categories. In addition, the rules of how they can be connected together are outlined. The categories of knowledge, formalised, are *object*, *process*, and *event*. The connections between them are implemented through *semantic relationships*. The SSKW provides a domain-independent knowledge warehousing architecture to store knowledge in a subject-oriented, semantic, integrated, systematic and meaningful manner. It incorporates object-oriented, semantic, and human-centric approaches to facilitate an intuitive and efficient communication. It prevents *loss of knowledge*, improves precision of output, and ensures efficient delivery of knowledge when required.

The SDA model and SSKW are integrated together in this research to form a human-centric DSS, *semantic-driven knowledge-enabled cognitive decision support system (SCDSS)*. SCDSS accumulates knowledge of many decision makers over time, thus if a decision maker leaves the organisation, his/her knowledge is retained through this system. Moreover, it automates the dissemination of knowledge across the organisation. Two evaluations were conducted to measure the performance of SCDSS against selected criteria. The results of the evaluations show that SCDSS successfully mitigates *availability*, *framing*, *contextual* and *group* biases, and generates new knowl-

edge during decision making process. The results also demonstrate the effectiveness of SCDSS in *knowledge sharing and enhancement*, *efficiency in producing output*; and the *relevance of knowledge* in the output.

The system can be accessed at <http://tasneememon.com/SCDSS/index.php>.

Keywords: Decision support systems, cognitive decision support, cognitive biases, knowledge warehousing, semantic knowledge representation.

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Publications

1. Memon, T., Lu, J., Hussain, F.: *Semantic de-biased associations (SDA) model to improve ill-structured decision support*. In Huang, T., Zeng, Z., Li, C., Leung, C., eds.: Neural Information Processing. Volume 7664 of Lecture Notes in Computer Science. Springer Berlin Heidelberg (2012) pp.483-490.
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3. Memon, T., Lu, J., Hussain, F., Rauniyar, R.: *Subject-oriented semantic knowledge warehouse (SSKW) to support cognitive DSS*. In Meersman, R., Panetto, H., Dillon, T., Eder, J., Bellahsene, Z., Ritter, N., Leenheer, P., Dou, D., eds.: On the Move to Meaningful Internet Systems: OTM 2013 Conferences. Volume 8185 of Lecture Notes in Computer Science. Springer Berlin Heidelberg (2013) pp.291-299.

4. Memon, T., Lu, J., Hussain, F.: *Human-centric cognitive decision support system for ill-structured problems*. In Guo, P., Pedrycz, W., eds.: Human-Centric Decision-Making Models for Social Sciences. Volume 502 of Studies in Computational Intelligence. Springer Berlin Heidelberg (2014) pp.289-313.
5. Memon, T., Lu, J. Hussain, F.: *Semantic-drive Cognitive Decision Support System Evaluation through Usability Testing*. Submitted to the journal of *Decision Support Systems*, a tier A journal.
6. Memon, T., Lu, J. Hussain, F.: *Subject-oriented Semantic Knowledge Warehouse Platform for Knowledge-enabled Business Intelligence*. To be submitted to *IEEE Transactions on Knowledge and Data Engineering*, a tier A journal.

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